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WIDER Working Paper 2018/178

Understanding the boom

A framing paper

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December 2018

United Nations University World Institute for Development Economics Research
wider.unu.edu

Abstract: A significant natural resource discovery creates excited popular expectations of imminent wealth. But the size of a boom is usually overestimated and the delay in receiving revenues is underestimated. This paper takes stock of the sequencing, timing, and scale of the development of a natural resource endowment; reviews the 'resource curse' literature; looks at benchmarks of scale and timing so as to put potential booms into the context of the challenges of growth and structural change in Africa; and, finally, gathers together observations on policy and institutional changes.

Keywords: developing countries, economic development, institutions and economic growth, macroeconomics, non-renewable natural resources
JEL classification: O11, O13, O43, Q32, Q33, Q35

Acknowledgements: I am grateful to Laura Brouwer for valuable research assistance, and to Benjamin Klooss, Stevan Lee, and Umar Salam for useful comments; the usual disclaimer applies.

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This paper has been prepared as part of a series of studies on 'Natural Resources, structural change, and industrial development in Africa' which is part of a larger UNU-WIDER research project on 'Jobs, poverty and structural change in Africa'.

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-620-3

Typescript prepared by Gary Smith.

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The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland, Sweden, and the United Kingdom as well as earmarked contributions for specific projects from a variety of donors.

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1 Introduction

A significant natural resource discovery creates excited popular expectations of imminent wealth. But popular expectations of imminent wealth run contrary to the conventional wisdom in social science that a resource boom confers a 'curse' on growth and development, with many people ending up worse off than they would otherwise have been. In general, the size of an anticipated boom is overestimated and the delay in receiving revenues is underestimated.

This paper sets out a framework for thinking about the challenges presented by a natural resource boom. I first take stock of the sequencing, timing, and scale of the development of a natural resource endowment. I then review the 'resource curse' literature to set out the key challenges. The debate about the resource curse has run for decades. The last 10 years has seen a closer focus on the variation of experience across resource-rich countries (Torvik 2009), rather than looking to explain the average experience of slower growth in resource-rich countries (Sachs and Warner 1995). Third, I look at some benchmarks of scale and timing so as to put some potential booms into the broader context of the challenges of growth and structural change in Africa. Finally, I gather together some observations on policy and institutional changes, which emerge from each section.

In sum, everything almost always takes longer than everybody at first thinks. The different counter-parties and interest groups then have dashed hopes. They also have different discount rates. Delay means that risks materialize as opportunities evaporate; that there are some potentially significant non-revenue dimensions to a resource boom means that a literature that revolves around the correlations of average effects of resource 'intensity', 'abundance', or 'dependence' is unlikely to provide any particular insight to the specific circumstances of any one resource-rich economy. Each country that finds the opportunity of natural resources disappointing does so in its own way. Equally, the path-dependence that early forms of regulation or rent-seeking can set up may condition the possibilities of prudent policy in the face of natural resource rents when they eventually arrive.

2 Sequence and timing

The conceptual foundation for thinking about sequencing is the observation that a natural resource endowment is best defined as an asset. This is the basis for the framing in Venables (2016). More specifically, with oil, gas, or minerals the focus is on a natural resource that is extracted on a non-renewable basis, as opposed to the natural asset of fertile arable land which yields production—and this echoes a key premise of Humphreys et al. (2007).

A mineral deposit below the ground which is an asset is still an asset when it is extracted to be above the ground. It is still an asset when it is transformed from mineral to money through processing and sale.

Holding fast to conceptual clarity means that what we refer to as the production of a mineral is actually a sequence of asset transformations. The labels 'production' and 'revenue' imply a flow of output or income, when those transactions are principally steps in a transformation of an asset

from one form to another.[1] A sub-soil mineral asset is shifted to be above ground over time ('production'). It remains an asset after processing and sale in exchange for money—a series of payments over time are a series of part-payments in the transformation of mineral into money ('revenue'). Although the treatment in fiscal accounts shows these payments as revenue, conceptual fidelity would show them as asset transactions below the line in financing.[2] This financial asset should then finance public spending—in particular the public investment to create public capital goods, often most simply thought of as public infrastructure. So, mineral to money to public capital—a sequence of asset transformations.

However, somewhat inevitably, conceptual clarity gets messy in reality. Everything takes time; mineral production runs for decades. But it also takes time, sometimes a decade or more, to take the steps that move from the discovery of a new mineral deposit to a point where there is material mineral revenue showing up in the public finances. Setting out the steps in the chain of events that runs from exploration through to any accumulation of public capital assets helps make clear how much time matters to understanding the impact of a mineral sector on the economy, and the many interesting ways in which the opportunity of a conceptually clean and positive contribution to investment, and therefore growth and development, can fail to materialize.

I next set out those steps between exploration and production, and endeavour to illustrate the extent to which the formal institutional framework—by which I mean the laws, regulations, licences, contracts, and government ministries and agencies that are supposed to operate them—shapes the opportunities and risks from natural resources.

2.1 A sequence of asset transformations

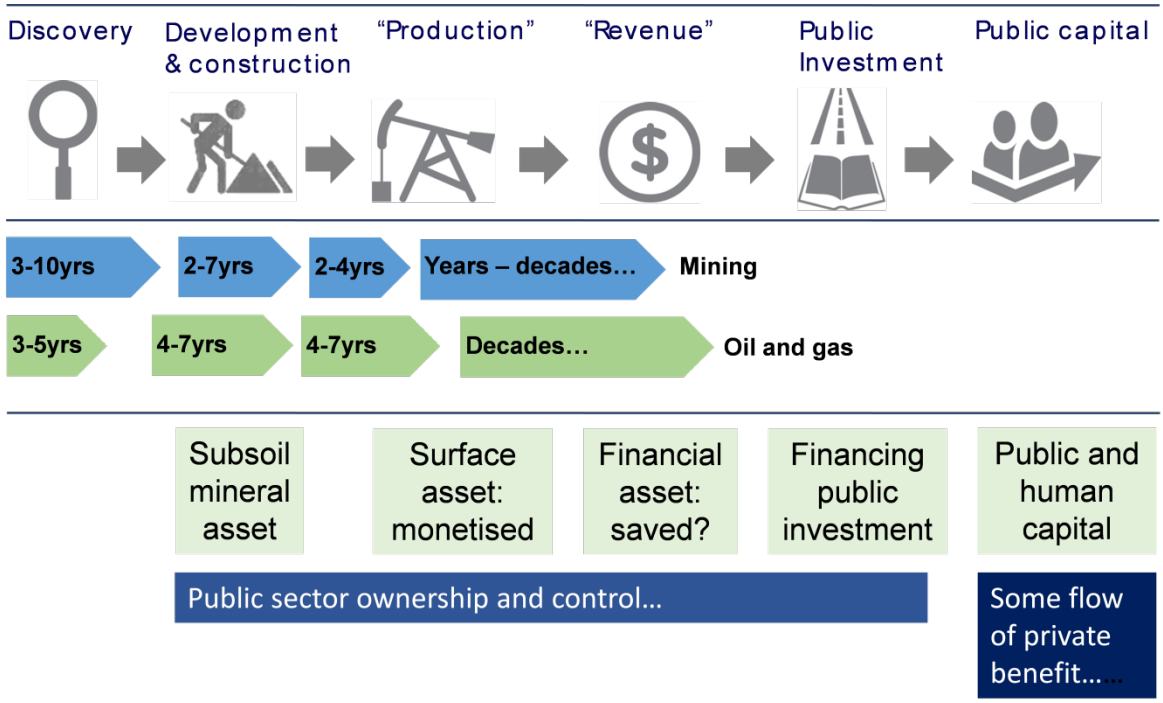
Figure 1 lays out the steps of an asset transformation in terms of the key stages in the development of a natural resource extraction project, together with an indication of the different duration of each stage of a project building up to production. The key differences between oil and gas extraction and mining are that 'conventional' hydrocarbon[3] extraction is more capital-intensive up-front, with capital investment in a mining project running throughout the life of the project instead of much of it taking place before production starts; there are usually more direct jobs in mining, which also has a bigger physical footprint, than in hydrocarbons.

[1] There is a nuance to this point, which is that some proportion of a natural asset converted into a financial asset could be identified as equivalent to an expected yield or return, and so constitutes income. It is the failure of many resource-rich developing economies to convert a sub-soil asset into sustained higher income that constitutes the idea of a 'resource curse'—pointing to arguments that if the expected value of, or return on, a sub-soil asset is negative, then it should be left in the ground until there is the institutional architecture required to make the most of it (see Stevens et al. 2015).

[2] This is an argument that has been applied to the treatment of receipts from privatization.

[3] 'Conventional' oil and gas are broadly defined as typical reservoirs consisting of a permeable reservoir rock with an overlying layer of impermeable rock (a trap or seal). This contrasts with reservoirs of 'unconventionals' such as shale and tight gas or oil that require constant stimulation through hydraulic fracturing ('fracking') and other techniques. This results in an ongoing need for investment that is more akin to mining.

Figure 1: A sequence of asset transformations



Source: adapted from Henstridge and Rweyemamu (2016) and AfDB/BMGF (2015a).

To discover the sub-soil asset, whether mineral ore body or hydrocarbon deposit, you have to go and look for it. Exploration is done in a mixture of ways: using geological mapping and modelling; using ground-, sea-, or air-based surveys; generating seismic, magnetic, or gravity data to understand whether there are deposits and the associated geological phenomena that will trap hydrocarbons, or yield an ore body. The footprint of these activities is small. It is specialist, often with a focused international supply chain. If offshore, the footprint is limited to the seismic vessel, water, and airborne support crafts, an office, and a shore base. If onshore, then the exploration activity has more of an obvious presence, but seismic surveys are transitory activities rather than any permanent establishment, except in rare circumstances. The concentration of skills and experience in exploration is high, and usually imported along with the risk capital that gets sunk into such exploration.

Exploration is risky, at least to the extent that it is a step into the unknown. As a result, the global pattern of mineral production reflects a long legacy of exploration around better understood geology. Only once something has been discovered does a prospective geological 'play' start to become de-risked. This explains the observation that there are more sub-soil assets, recorded as mineral reserves, in the OECD than in Africa (Collier 2010), when geology would provide for a more uniform global distribution across continents.

Most companies will only drill when they are reasonably sure they will have a result. As the risk is mainly geological it can be analysed down to a well-understood level. The footprint and cost of drilling is bigger than seismic activities. For hydrocarbons, there is then often the development of a programme to drill successive exploration wells. At this point, there are more people involved, and some increase in the supply of services, both specialist foreign industry services and domestically sourced non-tradeable services such as accommodation, transport, and catering. There will be an increment to employee income tax once a company staffs a permanent establishment.

If there are commercially viable discoveries, the investor will build up quite a large organization. If it is a multinational, it will tend to bring in established standard operating procedures, both of a specialist nature and as part of the regular running of a large business organization.

Commercial viability switches a project from the discovery phase to a development phase. At this point there will also be a switch in the basis for interacting with the state. The terms and conditions for exploration licences may be less complex than those typically associated with the production contracts and regulations, which may be subject to negotiation. At the same time, the first commercial discovery in a geological area quickly de-risks exploration strategies of other companies, and that shifts the balance between exploration risk and expected return for a mix of investors, and for the government.

The development phase switches to a construction phase once a contractor makes what is usually known as a 'final investment decision' (FID). By this point, there will often have been considerable investments in understanding the geological characteristics and risks of a hydrocarbon deposit; in the engineering appraisals and designs, which also have 'technical' risks; and in commercial appraisals and market risks; as well as any 'non-technical' risks—for example, the largely political risk of future changes in fiscal terms and conditions. The FID means a commitment has been sunk into the project and country—a point of no return. This has considerable risk for the investor of a hold-up problem. There are also risks for the government if it turns out the deal is not seen to be somehow fair in the long run.

The construction phase of a conventional oil and gas project is when the big capital investment takes place. In oil and gas this can amount to several billion dollars, much of which might be offshore; in mining, capital expenditure is lower at this stage, but it will often be ongoing during the life of the project, with relatively less sunk up-front. Some of the capital investment is on highly specialized precision engineering, but other components of these projects are literally construction, including bricklaying, carpentry, metal work, plumbing, and electrical works.

In oil and gas, if a large onshore facility is part of the project, such as a plant for cooling and liquefying natural gas, then there will be several thousand jobs during construction. Though it is also capital-intensive, mining creates relatively more jobs during the operations phase than oil and gas, which will only number in the few hundreds.

During the operations phase, natural resource projects will start to yield revenue. This, broadly, goes in two stages: there is a period during which revenue to the government is depressed as the project takes a share of the profit to re-pay capital investment, known as 'cost recovery', or the contractors' corporation tax liability is zero owing to carried-forward capital investment allowances. Once that phase is completed, then most modern oil and gas projects will typically see a larger share of the rent being transferred to the government.

The management of revenue is part of the management of the public finances writ large. The debates about how much to save and how to save, and how much to spend, and on what, are centred on the phase which turns rent into public spending. This process is complex enough without the extra risk associated with large and sometimes volatile receipts.

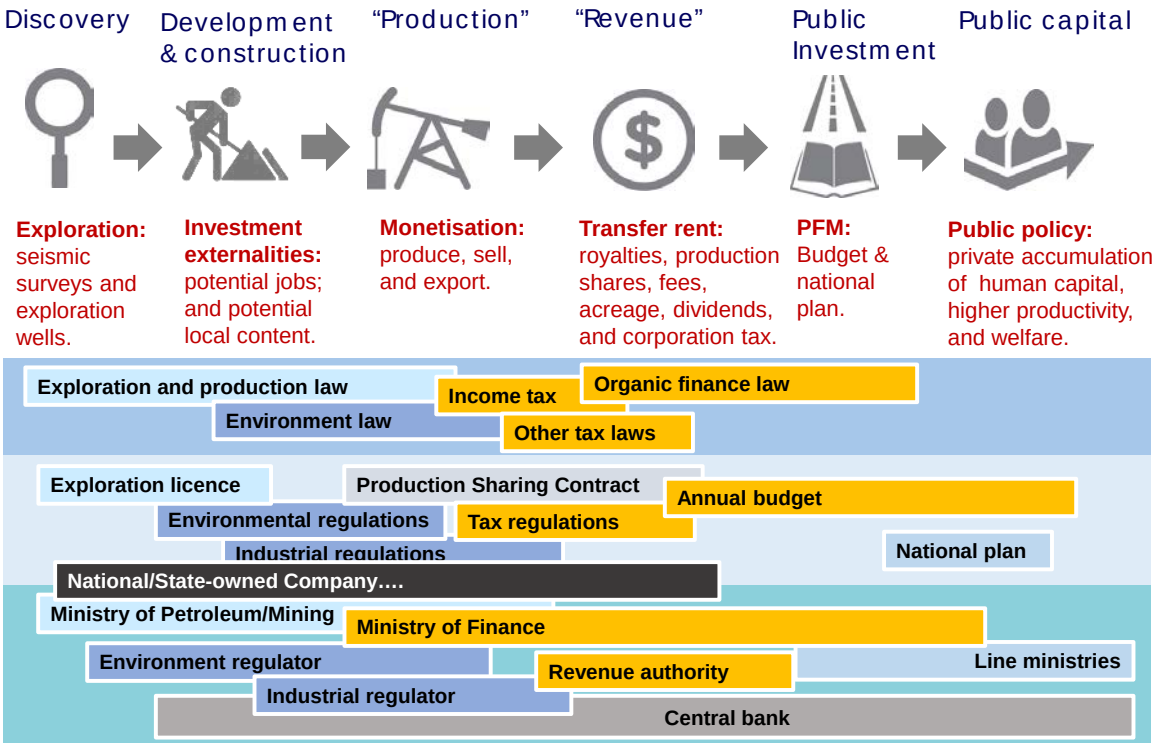
It is also the case that in some countries even modest receipts, when set against gross domestic product (GDP), can represent large inflows against the other components of the balance of payments, or the balance sheet of the central bank, or even the banking sector as a whole, making for monetary policy challenges that are a corollary to fiscal policy challenges—a point on scale to which we will return.

These asset transformations entail interactions between state regulation and public policy and the usually foreign private investment to finance investment at the scale needed by hydrocarbons and large-scale mining. It is this sequence of transformations of a state-held sub-soil mineral asset, through the mix of public investment and private business activities, that unlocks the growth and development opportunities, and in which the risks to a positive development outcome can be found.

2.2 The legal and institutional context

Wrapped around that sequence of asset transformations is the institutional context—the laws, regulations, licences, contracts, and the ministries and agencies with the legal mandate to implement them. Figure 2 provides an illustration.

Figure 2: The legal institutional context



Source: adapted from Henstridge and Rweyemamu (2016) and AfDB/BMGF (2015b).

The specifics of this legal and institutional context will vary across countries. However, Figure 2 provides a stylized framework for gauging the institutional and policy challenges at each stage in an asset transformation. Exploration is typically governed by a law and a licence with one ministry as the policy authority (the light blue boxes). For a private company, exploration is a fairly self-contained activity.

Once a discovery is made, there is a process that engages a broader range of ministries and agencies, such as those covering the environmental impact.[4] The contractual obligations are more complex for the development and then production of a discovery. With each new government ministry or public agency involved, there are growing possibilities for inconsistency between legal

[4] While environmental impact assessments (EIAs) are a requirement prior to any exploration activity (seismic and drilling) in all jurisdictions, once a discovery has been made the assessments relate to production, not just exploration.

mandates, regulatory authorization, and the agenda and interests of each particular organization. This elevates the stakes on interactions between the contracting company and a mix of government agencies.

A company will go to FID after working to assess and mitigate as much risk as possible—the geological, engineering, market, and non-technical risks associated with the political economy in which they will be operating. They will get to this point on the basis of detailed plans that will have had to secure government approvals.

The construction phase broadens out the local supply chain. Indeed, for hydrocarbons this is the phase with the most direct hires. The project will then have an interface with the labour market and a broader mix of business suppliers, and the associated laws and regulations (the mauve boxes in Figure 2).

In many countries, one of the biggest components of this framework is the national or state-owned company. It may have no in-house capability to operate any stage of a natural resource project—though many do—yet will have an involvement for and on behalf of the government. In particular, it may hold any share of a consortium assigned to the state, led by one company as operator, in the development and production of a mineral asset.

The administrative and policy complexity goes up as rents go into the fiscal arena. There is an interface between the exploration and production law and regulations and the law and regulations governing taxes more broadly, and in turn with the organic budget law and other instruments that govern the operations of public finances, which shape and constrain decisions.

Before going further into the economic context, I turn to the literature on the impact of natural resources on growth and development.

3 The literature

The literature that reviews the development trajectory of resource-rich economies highlights weak growth and disappointment. The initial focus was a debate on why, in an apparent paradox, resource wealth is a 'curse' for development.

There have been two main threads of analysis contributing to this broad debate: first, is there actually an impact on growth and development? Second, if so, what are the transmission mechanisms—in other words, why is it that some countries have suffered, but not all? One key line of argument, to which I return, is that the impact on growth works by endogenously weakening institutions, and so compromising policy to manage the impact of a boom and squandering resources that could have been invested.

The idea of a 'resource curse' was highlighted by Auty (1988, 1993), in particular with a review of the experience of the oil boom and crash in Trinidad and Tobago (Gelb 1988).[5] The trajectories of a mix of other countries, such as Nigeria and Venezuela, had common elements, including a sharply appreciated real exchange rate. A debate of now decades has been sustained, and has been subject to multiple surveys. More recently these include: Frankel (2010), van der Ploeg (2011), Ross

[5] Rick Auty coined the term 'resource curse' in 1993, building on the title of Alan Gelb's edited volume (1988) asking whether resources were a 'curse or blessing?'.

(2012), Deacon (2011), Gilberthorpe and Papyrakis (2015), Venables (2016), and van der Ploeg and Poelhekke (2016). Badeeb et al. (2017) provide an overview of the evolution of the resource curse thesis, and conclude that 'there is currently no consensus regarding the existence of a natural resource curse. If the curse is a relevant concern, the disparate literature certainly indicates that its ubiquity should not be exaggerated.' The point is to explore what the literature might offer as an answer to the question: what follows for other countries which might be facing a potential resource boom?

The many papers prompted by Sachs and Warner (1995) using cross-country regressions were exploring average effects, and looking to hold some variables constant to isolate correlations that could point to causal mechanisms. The statistical problems with cross-country regressions, combined with endogeneity in the chosen variables, render this swathe of papers problematic. Van der Ploeg and Poelhekke (2016) argue that the quantitative evidence is at best mixed but not strong. The variables used to capture resource abundance, intensity, or dependence suffer for being endogenous (Brunnschweiler and Bulte 2008; van der Ploeg and Poelhekke 2010).

In any case, measures of the level of natural resources are trumped by the impact of volatility. It is hard to distinguish empirically between the effects of institutional quality, financial development, or the political environment because they are all correlated. In general, there are omitted variable biases and multiple confounding factors at work. More promising are approaches that use a mix of identification techniques, such as difference in differences on natural experiments, to get at statistical power in country-specific studies.

The attention of the literature has switched away from looking at average effects to explore in more specific terms the mechanisms that may mean an impact on growth and development from resources (Torvik 2009). There is a mix of possible mechanisms, but here I just look at two categories because each has a different class of policy responses. One is the impact of resource revenues and the associated fiscal and monetary policy choices for managing them. The other relates to the impact of resources on institutions, for which there are fewer textbook-type policy recommendations.

3.1 'Dutch disease' and volatility

One common explanation of slow growth arising from natural resources is the Corden and Neary (1982) analysis of 'Dutch disease'—when there was a manufacturing recession in the Netherlands once the natural gas from the Groningen gas field was associated with an appreciation of the real exchange rate, which squeezed employment in tradeables.[6]

The appreciation of the real exchange rate is a powerful change in relative prices. It can be driven by a surge in foreign direct investment (FDI), by an increase in volume of exports as production for export comes on-stream, or by a sharp increase in the price of the exported commodity—primary commodity prices being notoriously volatile. The impact of 'Dutch disease' has also been analysed by van Wjinbergen (1984), while the impact of volatility on growth was a key transmission mechanism for van der Ploeg and Poelhekke (2009).

There is an important distinction to be made between the real exchange rate change that is a fundamental consequence of an increase in natural resource exports, and changes in relative prices which are too sharp for the resulting reallocation of resources to be smoothly accomplished—such as could be driven by commodity price volatility. On the other hand, Lee (2018) argues

[6] The term 'Dutch disease' having been coined in *The Economist* in 1977 in an article on these developments.

persuasively that the permanent appreciation of the real exchange rate is an important consequence of raised natural resource export income, inducing stronger supply of non-tradeable goods and services to meet demand. This happens with all export activities, not just natural resources. Investment in non-tradeable production can be the major driver of job creation.

There is scope for economic policy to manage the impact by dampening the impact of changes in relative prices. This could be achieved through care in not spending sharp increases in revenue, or by using monetary policy to sterilize shifts in the balance of payments. That this is feasible does not mean it is easy. There are examples of careful management of surges of foreign inflows—which includes international aid transfers, which are sometimes as volatile as commodity prices. But the analysis involved in separating out volatility from underlying fundamental shifts in relative prices, and then the politics of deferring expenditure, especially in a low-income country, are especially difficult.

The policy prescriptions for managing spending and savings decisions, such as those that apply the 'permanent income hypothesis' or the Hartwick Rule, or Hotelling's Rule, also rely on such a decomposition, typically being illustrated by projections of fiscal receipts with constant commodity prices (see, inter alia, Collier et al. 2010; van der Ploeg and Venables 2013).

The challenges of introducing robustly valid theory to the reality of volatility and the challenge of sustaining technocratically strong policy positions in the face of popular expectations for more wealth quickly should not be underestimated. This is why ideas such as putting fiscal rules into law, having dedicated legislation to mandate savings, or creating stand-alone funds, while sound in principle, are problematic in practice. In the context in which they are needed to hold political pressure at bay, they would not survive; if they can be sustained because the political environment protects their integrity, they are not needed.[7] Such considerations of political context are also important when looking at the literature on the role of resources in shaping the institutions of public policy, with an impact, in turn, on growth and development.

3.2 Natural resources and institutions

There is a debate on the role of institutions as a mechanism for the resource curse. My focus is less on whether, on average, there is a role, and more on the thread of analysis of how such a mechanism might work.

There are two main arguments. The first is that only initial conditions matter: if institutions were weak to start with, the impact of natural resources on growth and development will be negative.[8] If they are strong, or simply strong enough, then there will not be a resource curse. The second argument is that the rents associated with natural resource extraction endogenously corrode the quality of institutions, which in turn affects growth. Of course, both effects could be in operation at the same time.

Lane and Tornell (1996) and Tornell and Lane (1999) cite dysfunctional institutions to explain disappointing economic performance in the wake of oil windfalls in Nigeria, Venezuela, and Mexico. Sala-i-Martin and Subramanian (2003) estimate the impact of the share of natural resource earnings in GDP on the quality of institutions and the impact of institutions on growth, concluding that 'some natural resources – oil and minerals in particular – exert a negative and non-linear

[7] For some analysis on this challenge, see Davis et al. (2003): an underlying concern is to avoid assuming the conditions exist for successful and sustained implementation of institutional remedies.

[8] This argument is also applied with respect to foreign aid inflows by Bourguignon and Gunning (2016).

impact on growth via their deleterious impact on institutional quality'. Mehlum et al. (2006) distinguish between producer-friendly institutions, where rent-seeking and production are complementary activities, and grabber-friendly institutions, where rent-seeking and production are competing activities (the origins of these institutions are in turn explained by Acemoglu and Robinson (2012)).

Alexeev and Conrad (2009) argue that the claims that natural resources negatively affect growth and that they degrade institutional quality are incorrect. They argue that the time frame used in cross-country regressions is too limited. And by using a prediction of a counterfactual GDP per capita in the absence of a high oil or mineral endowment, they argue that natural resources do not undermine the quality of existing institutions—which may have been weak to start with. As already argued, the study of *average* effects of natural resources on institutions and growth might be a fallacy in general, because institutional change itself is dependent on pre-existing institutions—we therefore have to understand the historical development of these (as discussed in the historical institutionalism literature).

Torvik (2009) argues that we have quite limited knowledge along which dimensions resource-abundant winners and losers differ, but proposes six that can shape outcomes:

- saving of resources income;
- presidentialism vs parliamentarianism;
- institutional quality;
- type of resources;
- offshore vs onshore oil; and
- early vs late industrialization.

The way in which any one of these dimensions would work could be through the incentive that resource abundance provides to elites to demolish institutions because it is in their interest. For example, by reducing accountability by weakening checks and balances, and so allowing them to grab more rents (for examples, see Persson et al. 2000; Ross 2001). This might not always be driven by politicians/elites, but could also be favoured by voters, as in Acemoglu et al. (2013).

Torvik (2016) argues that natural resources may still influence institutions on a case-by-case basis, and the question is why natural resources contribute to prosperity in some places and to more poverty in another? And the normative implications: what does it imply for the design of policy and institutions?

This literature also throws up a few further points by way of interim conclusions:

- *The various explanations of a 'resource curse' effect can often be linked:* commodity price volatility can provoke sharp changes in the real exchange rate, elevating risks to investment; elite rent capture with weak accountability implies little space for technically strong economic management or careful long-term planning of public investments.
- *There is some evidence that a key transmission mechanism of disappointment from natural resource discoveries is through the impact on politics, institutions, and structural change.* The corollary is that the sequence of events that follow discovery offers some opportunities for policy to shape or condition the economic and political impact of the transformation of mineral assets. Some countries have not fallen foul of the threatened curse. It may be difficult to avoid, but it is not inevitable.
- *Cross-country regressions with average correlations are unsatisfactory* for using variables such as resource dependence or abundance, which not only risk being endogenous, but which also

only capture one step in the sequence of asset transformations through which resources interact with the growth and development process.

In sum, each country that finds the opportunity of natural resources disappointing does so in its own way. As Venables (2016) points out, there is no single reason why using natural resources for development has proven so difficult.

4 Magnitudes

While in general the size of an anticipated boom is overestimated and the delay in receiving revenues is underestimated, it is also the case that the steps for developing a resource discovery, the extent to which it has an impact, and the scale and timing of those steps are also often under-appreciated. Figure 1 showed that it can take decades to get from exploration to production, in both oil and gas and in mining—at least for large mining projects.

Moreover, for hydrocarbons the biggest impact on direct employment comes during the construction phase rather than during operations. The big numbers on FDI are also ahead of production starting up, although much of FDI is likely to be international finance for capital goods imports rather than having a direct impact on the economy.

These points on sequencing and timing are of relevance to the institutional environment into which revenue would eventually flow. If the elite have expectations of a boom that will arise when the revenue comes in, they will take early action so as to be nicely positioned to secure rents. The other aspect, to which we return in this section, is how sequencing and timing interact with expected scale—but not so much the magnitudes surrounding the project, rather the scale of economic impact.

First, however, two examples that show that the scale of a resource boom can be made to look big or small, depending on the comparators against which it is benchmarked. Perceptions of scale depend on the perspective one adopts.

In 2012 there were inflated expectations about the prospects for oil in Uganda. It could be seen as really big: P50 proved reserves had been declared by Tullow Oil at 1.1 billion barrels. In 2012 the international price for Brent oil averaged US$111 per barrel (BP 2017). A simple multiplication would therefore value those reserves at US$122 billion, which was around four times the 2012 GDP. Big numbers, but misleading:

- First, you cannot get all the oil turned into cash all at once: it takes time to turn reserves into production—the life of most oil projects is around 25 years—even if the government and the private contractor are both in a hurry for cash sooner rather than later.
- Second, Ugandan oil is waxy and landlocked: it does not fetch the same price as Brent crude oil, and it is costly to export.
- Third, the sizeable capital costs involved in three interlocked projects— oil production, a refinery, and a heated export pipeline—required international investment. There was then a tough problem of coordination across those three large and risky projects, and it has been a persistent problem.

In fact, oil in Uganda is quite small as well as a distant prospect. Even just dividing the gross figure by total population, and so ignoring any costs involved in bringing a sub-soil asset above ground, reduces it to US$3,500 per person. But getting realistic and allowing for time to develop and produce and export the oil, with all the costs associated with that, and using a more conservative price of US$75/bbl, then Henstridge and Page (2012) show that total revenue to government

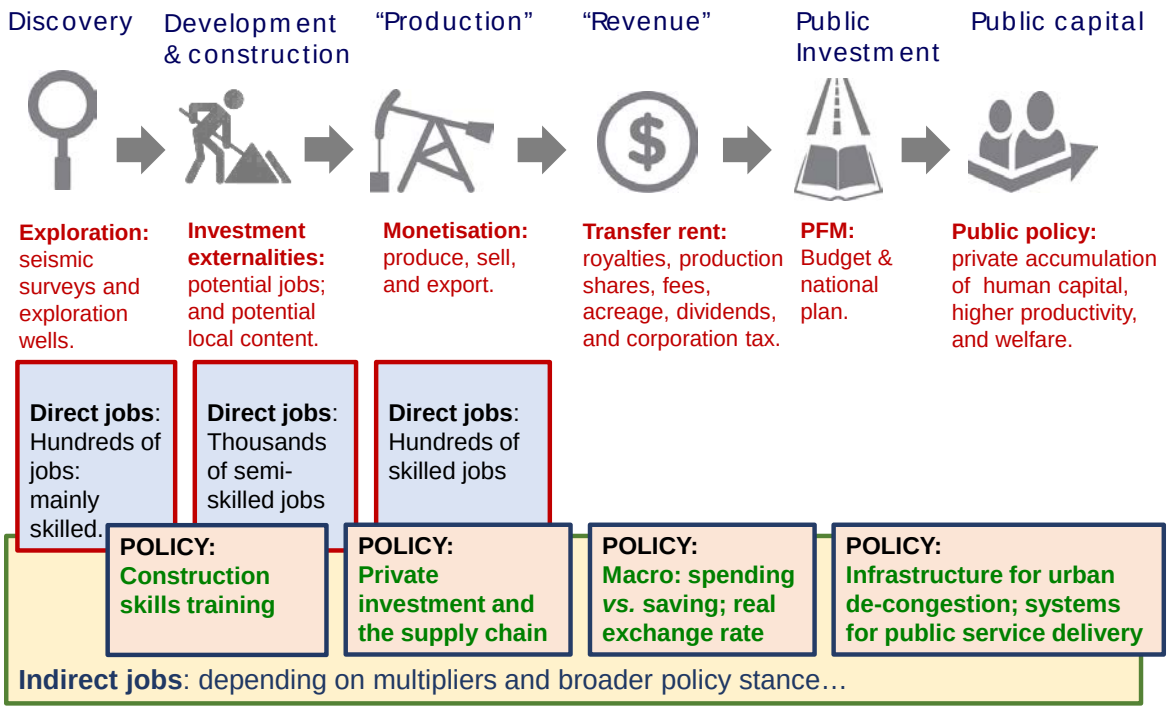
would be equivalent to 5 per cent of non-oil GDP, and would only amount to US$41 per person per year in 2030. Not insignificant, but not of itself transformational.

To take another hypothetical example: the development of natural gas production and export in Tanzania could be simultaneously very big and small (Henstridge and Rweyemamu 2016). The projected total FDI of around US$27 billion was large—that is a lot of money by any standard, and it matches the whole of Tanzania's GDP in 2011. At the same time, if it ever goes into production, the scale and time that was expected for natural gas in 2012 meant that it would end up being actually quite small: even if, optimistically, production had been set to start in 2021, by 2030 projected revenue of US$2 billion each year would be equivalent to US$28 per person, and just 1.6 per cent of GDP. In those projections, peak revenue to government would amount to 3 per cent of GDP in 2035. That is an important increment to public revenues. It is not, however, of itself transformative. However, at the same time it could be big enough to warrant careful monetary policy responses if it proved volatile.

A broader perspective on the scale of a boom is to look at the scale of economic impact of each step in the sequence of asset transformations. For hydrocarbons there are a few direct points of contact, and relatively few directly created jobs; the broader impact of natural resources on structural change will be indirect, could start well ahead of any revenue flows, and will be mediated by a constellation of policy positions.

Figure 3 provides an illustration of the main linkages between a resources project and jobs—with some of the key mediating areas of public policy listed as well. It is calibrated for conventional hydrocarbons rather than mining, where there will be thousands of direct jobs during production, and capital investment will run through much of the lifetime of the project.

Figure 3: The broader context: jobs and policy



Source: adapted from Henstridge and Rweyemamu (2016).

The calibration for conventional hydrocarbons serves to make a more stark point about the broader economic impact of a natural resources project when the direct job creation only swells

to thousands of jobs during the construction phase of a project. It only takes a few hundred people to run some oil or gas projects, many of whom will be highly experienced industry specialists. It is, of course, a well-understood statement of the obvious that a hydrocarbon project does not of itself drive a shift in employment in a developing economy.

There is, however, scope for phases of policy to influence the indirect impact, including on jobs. The areas of policy of potential relevance are illustrated in Figure 3: (1) construction jobs and skills training; (2) the environment for private business investment—which can increase ahead of the development of the natural resource, and which includes 'local content' which seeks to support firms who can be part of an international supply chain; (3) appropriate fiscal policy management in the face of possibly large and volatile macroeconomic flows; and (4) the efficiency and focus of public investment, including in infrastructure and other forms of public capital.

4.1 The construction sector and jobs

Through the exploration phase and the development phase, direct economic impacts are limited to the hiring of a few hundred people, and some supplies for an office and an exploration programme. The construction phase sees the first material impact on jobs, many of which may be semi-skilled. What gets built may be limited to onshore facilities for offshore hydrocarbons, such as with the oil developments in Ghana. But it could include building or assembling a facility for the 'trains' which condense natural gas to a liquid by cooling it to –161°C (–260°F) so that it can be exported by ship as liquefied natural gas (LNG). In mining operations, the development phase could involve substantial ongoing employment.

Where construction is involved, there is likely to be a material impact on the labour market for a range of semi-skilled and skilled workers, such as construction workers, bricklayers, metal workers, carpenters, plumbers, and electricians. In a low-income country there is unlikely to be an elastic supply of such workers to fill some thousands of jobs. It was estimated that some 4,000–5,000 jobs would be created directly during construction of LNG facilities in Tanzania. This compares to a range of jobs on other LNG construction projects ranging from around 2,000 in Australia to 8,000 in Angola (OPM 2013).

Although a few thousand is a few jobs when the labour force numbers millions, there are not the skilled people to meet this demand. Training will be essential for secure project delivery, and it may well need a specific initiative. An example is provided by the analysis of the labour force in Tanzania in anticipation of large-scale LNG. An assessment of vocational and educational training needs (VSO 2014) concluded, among other findings, that: (1) those graduating from 'vocational education and training' are not directly employable; (2) the trades which will be needed are not being taught; and (3) in any case, the training is low quality. However, most of the areas in which training would be needed to fill the jobs created as part of the investment in hydrocarbons were not sector-specific: the VSO assessment showed that a significant number of the skills needed are transferable. These include the skills needed in metal work, building works, civil engineering and infrastructure, mechanical work, and electrical work.

This is an important point for the economic impact of the boom when revenue starts. A natural resource boom leads to a construction boom: it is a facet of Dutch disease that the appreciation of the real exchange rate raises the returns to non-tradeable activity, but also to non-traded capital, which is mainly structures. If the construction sector is weak, the supply of structures is inelastic, and the real estate boom is more in prices than buildings. If, however, there are growing numbers of people with transferable construction skills, then the supply of structures is more elastic.

This points to a policy position that training to a standard good enough to work on the construction phase of a natural resource project means people with those skills will be in demand as the boom kicks in. That there is a shared interest in sufficient-quality training of more than enough people between the natural resource company and the government seems clear. Training tens of thousands, even if only a few thousand are needed, could provide mitigation for the risks associated with a sharp appreciation of the real exchange rate. It would mean running a training organization that could cope with 1,000+ people each year for more than 10 years.

4.2 The environment for private business

There are three channels of impact from the natural resource sector to the broader private business environment. One is through expectations, another through the supply chain, and the third is broader, being conditioned by the array of policies that can affect industry and business.

First, the impact of the natural resource sector on private business can start with the discovery itself. There is evidence that the news of a discovery has an impact on private business because it can sharply shift expectations about future levels of national income. In a panel of 180 countries over the period 1970–2012, Arezki et al. (2017) show that investment rises robustly after the news of a giant discovery. There are contrary results from Poelhekke and van der Ploeg (2013) on the impact of resource rents on non-resource FDI in the period 1985–2002, who argue that resource rents depress non-resource FDI in the long run. This can be argued to be the Dutch disease, or the resource curse more broadly, in action, given that the effect is prompted by the rents from natural resources.

But using data taken during the more recent commodity boom between 2003 and 2012, Toews and Vezina (2017) document a 58 per cent increase in non-resource extraction FDI in the two years following a giant natural resource discovery. They also use detailed multiple waves of household survey and firm census data to track the impact of a giant discovery of natural gas in Mozambique on further FDI for other business activities. They estimate that each FDI job results in 6.2 additional local jobs. The detail in their data enables them to provide more information on job creation, arguing that:

> Since 131,486 jobs were directly associated with FDI firms in 2014, we can infer that almost 1 million jobs, out of around 9.5 million total jobs in Mozambique, are the result of the FDI multiplier. Our results suggest that around 55% of the extra jobs created are informal rather than formal, around 65% are women's jobs rather than men's, and that it is only workers with at least secondary education that benefit from the wave of job creation.

Second, to the extent that there is a potential supply base, the more an oil or gas or mining project has a potential role in elevating domestic firms to the standards of quality necessary for participation in an international supply chain. This is a point that has been well made by John Sutton, for which his series of *Enterprise Map* books are a material contribution.[9]

Part of the framework for this impact is provided by regulations and policy relating to 'local content'. In some instances, there are requirements for the international contractor to buy inputs locally. However, in some instances that means that a domestically registered company proceeds

[9] See for example Sutton et al. for Enterprise Maps for Ethiopia (Sutton and Kellow 2010), Ghana (Sutton and Kpentey 2012), Tanzania (Sutton and Olomi 2012), Zambia (Sutton and Langmead 2013), and Mozambique (Sutton 2014).

to import goods and services, instead of the oil or gas or mining company, or one of their tier 1 suppliers, importing directly. That serves to raise costs and offers scope for rent-seeking: only a few will be able to take up a coveted position as the domestically registered supplier. That there is a monopsonist compelled to buy locally likely limits competition.

Finally, almost regardless of whether there is a natural resource sector in an economy or not, the rate of private investment, business formation, and firm growth will be conditioned by an array of public policy positions which together constitute 'industrial policy', whether labelled as such or not. These could range from monetary policy shaping prospects for credit growth and the appetite for risk in the financial sector through the structure of land ownership and the functioning of the land market, to the extent to which the education system leads to an educated workforce with people in a good position to develop skills and productivity.

The impact of the natural resource sector on the broader business environment will come through the way in which policy is a consequence of accumulated interests which will shape the 'institutions' (in the Douglass North sense) of the economy. The argument here is that if the natural resource sector is significant, as it so often is in low-income countries, then the more that the activities which surround it are conducive to rent-seeking, the stronger will be the interests in reduced economic openness and competition. For example, a national oil or gas company set up to extract rent—as seems so often the case—may be weakly transparent or only loosely accountable; the process for awarding licences may be, in practice, non-transparent with no element of competition, such as through an auction; or local content policies may only serve to set up connected companies to be local monopolists in the industry supply chain. In these instances, they will strengthen interests in further elite rent-seeking, or 'extractive institution' formation (Acemoglu and Robinson 2012), or 'closed order political settlements' (in the language of North et al. 2009). In turn, the impact on economic openness, or a flexible or competitive economy, will be deleterious.

This point has further resonance when one considers that a long-term process of growth and structural change means huge reallocation of people and resources, perhaps most clearly in migration from rural and agricultural employment to urban service sector jobs. Even in China, most modern sector jobs were non-tradeable services jobs. Gollin et al. (2013) show that in natural resource-rich, low-income countries, cities are not centres of production for tradeable goods, rather they are 'consumption cities'. Lee and Vanino (2018) establish the important point for thinking about the role of extractive institutional settlements, and the long-run structural change of resource-rich economies, that rent-seeking and predation is a lot easier on non-tradeable sectors than internationally tradeable sectors. The logic is that squeezing a tradeable activity, for example by raising costs, threatens the whole venture because of competition in international markets or the availability of imported substitutes. Non-tradeable sectors do not have that existential threat and can be sustainably squeezed quite hard. Sustainable rent extraction is then compatible with sustaining extractive institutions, and hence an array of industrial policies which may not be good for sustained growth in competitive private business.

4.3 Fiscal and monetary policy management

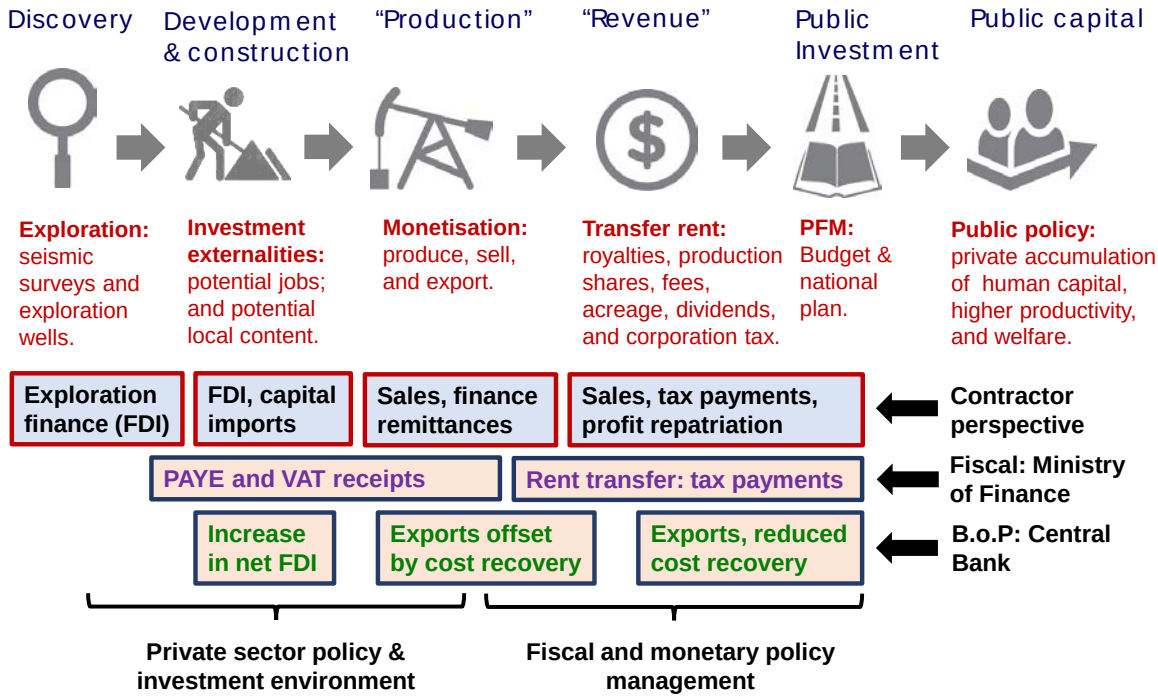
Macroeconomic policy is at the heart of the literature analysing the 'resource curse', and offering advice on how to ward off the curse. This is because rents are central to thinking about natural resources and they mainly show up in the economy in the public finances.

Figure 4 is an illustration of how some macroeconomic flows shift as a natural resource project goes through its phases, and sets up the sequence of asset transformations. Those that matter to the company as contractor relate to the commercial sustainability of the project as a business

venture. The ministry of finance sees the fiscal elements ahead of the others, while the central bank will be most concerned with the exchange rate and inflation as targets for monetary policy.

The macroeconomic magnitudes that matter when scaling the impact of a natural resource project depend on the variable of concern. Initially, the scale of FDI being brought onshore could be big in relation to other components of the balance of payments. That impact will be of more immediate interest to the central bank than the ministry of finance. If there are material foreign inflows, they could be particularly big in relation to the central bank balance sheet, possibly also the consolidated balance sheet of the banking system in a low-income country, and hence be a handful for monetary policy to manage if there are threatened sharp movements in the exchange rate, reserves, or money.

Figure 4: Natural resource project sequencing and macroeconomic flows

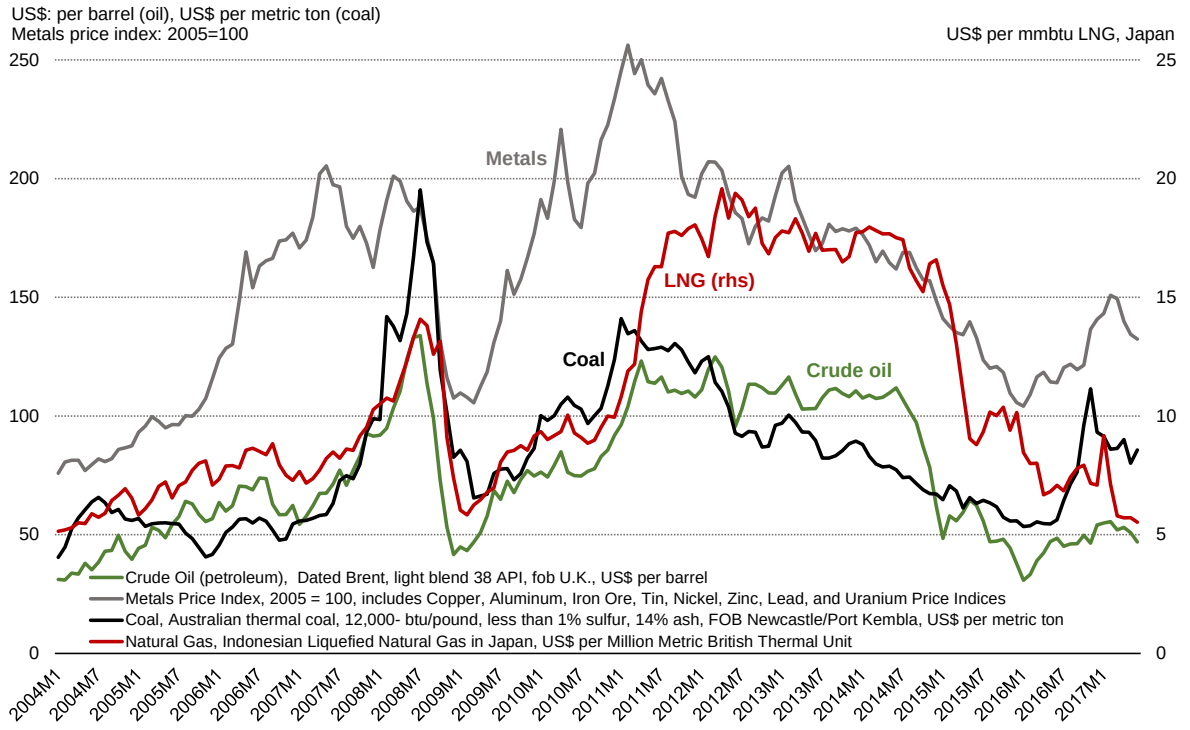


Source: adapted from Henstridge and Rweyemamu (2016).

If there is the sort of FDI boom that Toews and Vezina document for Mozambique, there will be a mini-boom in fiscal revenue from import duties, sales taxes or VAT, and income taxes. None will be immediately associated with the operations of the natural resource sector, and they will be well in advance of payments of rents from natural resources. Tanzania may provide a good example in that expectations that offshore deep water natural gas will be produced in the next decade or two are fading, but there was a period earlier this decade of material payments of VAT and income taxes arising from the exploration phase, and the beginnings of the development phase, of large potential gas projects.

Turning to the bigger, eventual, fiscal impact of resource revenues, they have an inescapable characteristic of volatility. Commodity prices are notoriously volatile (Figure 5).

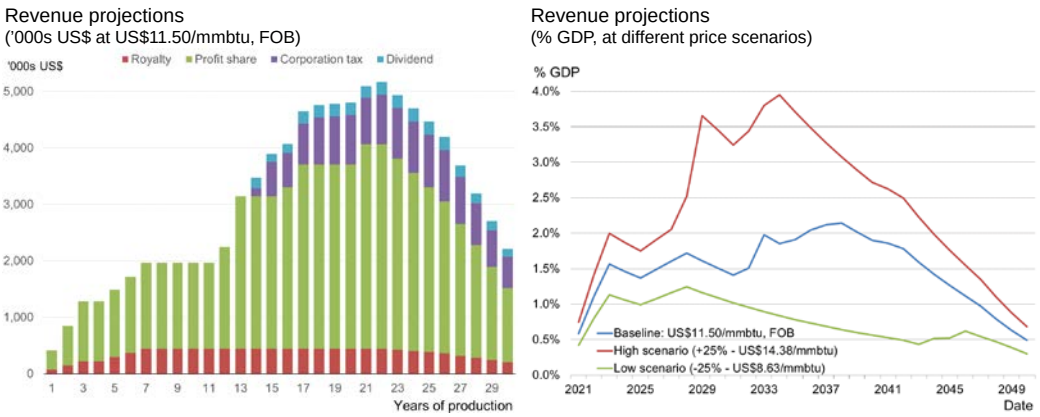
Figure 5: Commodity prices



Source: author based on IMF primary commodity price data (www.imf.org/external/np/res/commod/index.aspx).

But even if prices are absolutely flat, and production volumes constant, revenues will often change from year to year. This is because the relationship between the value of production and the revenue associated with it can change from year to year as the fiscal regime accommodates a phase of cost recovery, or the carried-forward capital allowances change, or the interest cost of finance changes. Figure 6 carries some illustrative projections of revenues from the possible, but now unlikely, large-scale offshore gas and LNG projects in Tanzania. The central projection of revenue in the right-hand panel varies each year, even though the price assumption is flat and the assumption of volumes of production after a ramp-up phase is flat though to a period of decline.

Figure 6: Revenue projections in Tanzania

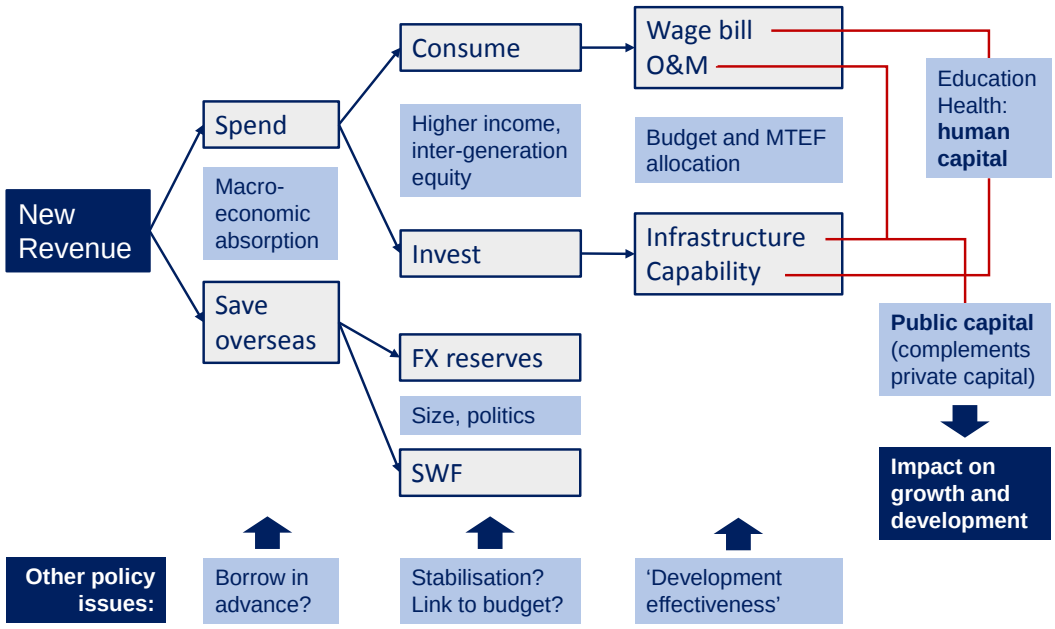


Source: author, based on data from Henstridge and Rweyemamu (2016).

Volatility matters for the impact of a boom because it makes building a budget and managing fiscal and monetary policy difficult, and because volatility means additional risk, if not outright uncertainty, for private investment, and that lowers growth and potentially contributes to a resource curse effect (see van der Ploeg and Poelhekke 2010).

Addressing these macroeconomic policy challenges is difficult overall, but some of them can be separated from the others by looking at a sequence of decision points. These are illustrated in Figure 7.

Figure 7: A sequence of macro policy choices to manage rents



Source: adapted from Henstridge and Rweyemamu (2016) and AfDB/BMGF (2015b).

The decision on how much to spend, whether on consumption or investment, and how much to hold offshore is an early choice. This was a decision that was foreseen by the Petroleum Revenue Management Act (PRMA) in Ghana. The choice is one that is intermediated by the rate at which foreign inflows can be absorbed. That in turn is a function of economic flexibility, in particular the supply elasticity of non-tradeables (Adam and Bevan 2004). There is also an early choice on whether to bring forward new natural resource revenues by borrowing in advance against the security of future expected revenues. There is reasonable economic logic which would analyse the decision in terms of the relative costs of borrowing and the rate of return on early investment and the discount rate applied to early consumption spending. There is also a strong political logic: borrowing to bring forward access to rents is a tempting source of finance for a political strategy to retain power. That points to sub-optimal economic returns from early spending financed by borrowing. The various accounts of Chinese loans to Ghana—outside the purview of the PRMA in terms of fiscal prudence—provide an illustration.

If resource revenues are to be saved, there is a choice between containing them within the procedures applied to foreign exchange reserves, which they would augment, and between setting up a dedicated sovereign wealth fund. If the amounts involved are big, then a dedicated institution that could be charged with maintaining their integrity would make good sense. However, there is the paradox that if the political environment is inadequate for prudential management of foreign reserves and the fiscal position, and something stand-alone is called for, then it risks not having the political environment in which to be sustained.

A second consideration is the extent to which a savings or sovereign wealth fund is tightly linked to the budget and expenditure processes. The PRMA in Ghana intermediates between oil revenue and the budget.

On the spending decisions, there is a balance to be struck between raising consumption in line with increased permanent income, and further transforming the mineral asset by using the rent to invest in public capital, such as infrastructure. The importance of a coherent link between resource rents and savings and the broader public finances can be illustrated by thinking about the role of different categories of public expenditure in the accumulation of private capital assets, including personal health and education, as well as the building up of public assets. Private and public investment are of course complements—people will invest in trucks if there are the roads and bridges that enable trade, for example.

But equally important, the returns to public assets, infrastructure in particular, are high when operations and maintenance spending is sustained. Adam and Bevan (2014) show that the returns to operations and maintenance of existing, but poorly maintained, public infrastructure are higher in terms of their contribution to growth than building new infrastructure. Standard fiscal classification has operations and maintenance spending as recurrent expenditure rather than investment. Similarly, the public expenditure that contributes most directly to people's accumulation of their own human capital is recurrent, being the salaries of teachers and medical staff, and the medical supplies, that are all part of improving and maintaining education, skills, and health through public service delivery. But if there are rules which limit the spending of resource revenues to investment, then the returns on existing public assets and the opportunities for human capital development, all of which draw upon recurrent expenditure, may be sub-optimal.

5 Institutions and policy stance

A set of policy issues has emerged throughout this framing of a natural resource boom. But whether policy implications, recommendations, or recipes are ever actually relevant to the reality of a resource boom is more a function of the politics of policy than the analysis of evidence informing recommendations.

The political economy of natural resources mainly revolves around the rents involved. The extent to which rent-seeking succeeds, and then those who extract rent succeed in sustaining their position through their influence on the institutional foundations of the policy process, is therefore key to even just glimpsing appropriate policy.

There is a long literature on institutions, both where they come from or what shapes them, and what follows from different institutional configurations. I made reference earlier to the work of North et al. (2009) and Acemoglu and Robinson (2012), to which can added the framework of Pritchett et al. (2017). In essence they all provide a framing of the way in which a political settlement shapes the institutional 'rules of the game', and drives the coordination of agents' decisions and expectations. The settlement could be the suspension of a threat of violence (North et al. 2009), or it could be an equilibrium division of the spoils of rent capture.

Such an 'extractive' institutional configuration is consistent with the strands of the literature on the resource curse which look at the role of rents in shaping institutions which determine growth out-turns. But as the literature argues, a resource endowment is not destiny. The interesting element of the institutions literature is the bit that tries to focus on what changes the institutional configuration.

In essence there are two things that can represent positive change. One is the development of impersonal transactions among elites. This is the key threshold condition for North et al. for moving from a closed-order settlement to an open-order one—loosely equivalent to a shift from extractive institutions to inclusive institutions in the Acemoglu and Robinson framework. A second is an external shock that disrupts the equilibrium of political settlement. In a resource-rich economy this could be driven by sharp changes in commodity prices and the disruption in the flow of rents that follows, or it could be a technology shock—perhaps one that makes fast-growing services tradeables rather than non-tradeables.

That point links to two other observations on the political and institutional foundations for policy. One is that cities in resource-rich economies are 'consumption cities' that have grown on the increased national income arising from a resource boom, with a strengthened real exchange rate increasing the returns to non-tradeable production, and to non-tradeable capital—as represented by a construction boom (Gollin et al. 2013). The second is that it easier for an elite to capture rents from non-tradeable than tradeable sectors (Lee and Vanino 2018). 'Consumption cities' might be efficient or they might be a symptom of growth-killing extractive institutions. If natural resource exports are very high, then it is expected and efficient for other exports to be low and for a lot of urban production to be focused on non-tradeable services—consider Australia. However, if institutions are fundamentally extractive, with private individuals extracting rents from natural resources and from non-tradeable producers in a way that pushes up costs and reduces competitiveness, then investment and production of non-resource exports is indeed suppressed. This is inefficient and bad for growth—consider Nigeria. Observing a high level of resource exports and high employment in non-tradeable production is not enough to distinguish between these two sets of conditions.

What follows from all that is that some policy choices made early on offer a different path forward to the institutional constraints that will shape or constrain subsequent policy decisions. Initial policy choices come right at the outset of the sequence of steps along a natural resource value chain.

These include the initial encounter between explorers and the relevant government ministry. If there are requirements for some elements of transparency and competition in awarding exploration licences, then there is already an openness to the governance of the sector. If a major discovery is made, then there will be a material economic impact in terms of FDI—and the experience of Mozambique implies that there is an opportunity for job creation at some scale. If the management of FDI provides for an open and competitive business environment, then the transactions between elites who might otherwise have sought to stitch-up particular sectors—particularly non-tradeables, such as brewing—may become more impersonal. Impersonal transactions among elites, particularly capital transactions, such as traded equity or debt, are a threshold condition for the switch from closed-order to open-order settlements. In a similar vein, a stitch-up of local content regulations may hold back inclusive open-order institutional settlements.

When eventually resource rents come into the line of sight of policy makers, the various macroeconomic policy choices will be better formulated and debated if the tone has been set towards openness and inclusive institutional settlements. This would be evidenced by elite consensus on wanting reasonable degrees of competition in markets for factors of production and non-tradeables, as well as open trade.

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